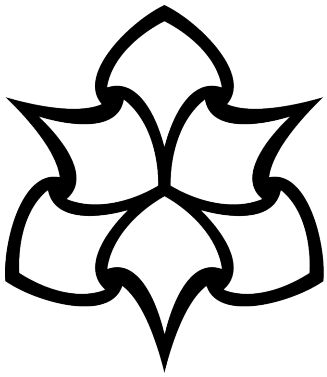

Supply Chain Management: an International Journal

The Role of Absorptive Capacity within Supply Chain Quality Integration

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The role of Absorptive Capacity within Supply Chain Quality Integration

Abstract

Purpose: There is a consensus suggesting that the theoretical underpinning associated with supply chain quality management practices remain evolutionary to current thinking. Therefore, this study explores how absorptive capacity (AC) supports supply chain quality integration (SCQI) by building product and process quality within a supply chain (SC).

Design: A comparative case study of global pharmaceutical manufacturers in a developing market was undertaken. A two-round qualitative research method was designed to collect data through 54 semi-structured interviews with pharmaceutical managers and senior managers.

Findings: The results demonstrate that AC is essential to the development of SCQI due to its ability to utilise valuable strategic and operational knowledge, which is important when improving consistent internal product and process quality, along with establishing a robust SC design. We found that AC enables companies to design their quality and continuously improve their products and processes among their SC members.

Research limitations: We acknowledge that these sets of findings are difficult to generalise to other sectors, however, we are confident that they can be extrapolated to other companies in the pharmaceutical industry.

Practical implications: The study develops a framework to support practitioners and decision-makers in order to leverage their AC towards facilitating their SCQI practices.

Originality: This study explains the role of the AC process in relation to SCQI practices, in the context of the pharmaceutical SC. The study profiles the characteristics of dynamic capabilities in order to increase the companies' competencies, processes and resources.

Keywords: Supply chain quality, absorptive capacity, dynamic capability

Paper type: Case study

1. Introduction

It is widely accepted that pharmaceutical supply chains suffer from trans-global operations due to the high complexity levels and contractual regulations that manufacturers need to comply with (Yu et al., 2010). Designing supply chains requires transparency and accountability, especially when bringing new products to market (Sharifi et al., 2006). Therefore, coordinating the design and manufacture of high quality products and medicines often needs to comply with demand quantity, both in terms of unit price and delivery schedule, is a key performance measure for any pharmaceutical operations (Asamoah et al., 2011). Nevertheless, achieving this goal consistently is difficult, notably due to the dynamics

in the environment; where manufacturing and Supply Chain (SC) issues, such as product recalls, are on the increase and impact firms negatively (Lawrence and Kopcha, 2017).One example was the recall of Vioxx by Merck and Johnson & Johnson, which affected the company's credibility (Narayana et al., 2014a). Furthermore, Friedli et al., (2010) highlighted that the majority of the problems relating to the product recalls of drugs are due to manufacturing issues, such as poor quality raw materials, incorrect packaging requirements and product contamination. As a result, pharmaceutical manufacturers must ensure that their drugs are fit for consumption and comply with standards throughout the SC (Escudero, 2016; Narayana et al., 2014b). These issues could be handled through raising an awareness within the SC by ensuring that quality is built into products and processes, from raw materials to consumed goods (Lawrence and Kopcha, 2017). Arguably, this can be managed through building dynamic capabilities by enhancing quality within the SC through sensing, seizing, and reconfiguring companies' resources (Teece, 2017).

A number of publications have also identified that managing quality within the SC helps companies reduce defect costs and improve overall operational and financial performances (Robelledo et al., 2009; Vanichchinchai and Igel, 2011). As a consequence, decision-makers seek to extend their quality management systems through their supply chain management practices, in order to further develop their Supply Chain Quality Management (SCQM) processes (Kaynak and Hartley, 2008). SCQM has become an issue of considerable importance, due to its role in increasing value and enhancing performance (Zhong et al., 2016). Nevertheless, our understanding of quality interfaces in the SC has become complicated and requires careful coordination between companies (Mellat-Parast, 2013). The key issues relating to the implementation of SCQM is a lack of explanation in terms of how companies can expand their quality implementation outside their boundaries (Lin et al., 2013). In addition, there is a lack of understanding regarding the most suitable way to absorb SC knowledge (Huo et al., 2014; Xu, 2011). Therefore, this paper develops the premise of AC processes within SCQI practices in the pharmaceutical sector. Especifically, the role of absorptive capacity (AC) process through acquisition, assimilation, transformation and exploitation to improve the SCQI. This study also considers the synthesise of internal and external quality integration (Huo, 2014, Zahra and George, 2002) across a pharmaceutical supply network. To achieve this aim, we have focused on the following research questions:

> RQ1: How and to what extent do pharmaceutical manufacturers implement SCQI practices to improve the quality of their products and processes?

RQ2: How and to what extent can the processes of AC be implemented within pharmaceutical manufacturers to facilitate the concept of SCQI?

The next section explores the mechanisms of reconfiguring SC quality related knowledge and the organisations' ability to absorb this knowledge and create value. We argue that despite the importance of quality being an integral element of achieving SCQM through the concept of SCQI, the process itself is somewhat undefined and lacks a clear roadmap towards building successful practices, without the ability to utilise the AC of SC knowledge.

2. Literature review

2.1 Supply chain quality management

Over the past few decades, the term "quality management" (QM) has provided solutions for different types of organisational problems and it has been recognised as a management philosophy that focuses on continuous process improvement aimed at satisfying customers (Wang et al., 2012). Unsettled markets have also forced companies not only to consider quality within their own organisations, but also within their SC (Mellat-Parast, 2013, Soares et al., 2017). Furthermore, quality by design practices exist in most proactive organisations and begin to be established within SC (Dong-Hua and Zailani, 2011;Collin et al., 2009). Quality by design was originally suggested by Juran (1992), who presented the quality trilogy, which consists of quality planning, quality control and quality improvement. The designed quality is considered an infrastructure for companies, along with quality data and process management, which all create inimitable capabilities (Nair, 2006; Anand et al., 2009). Consequently, the concept of SCQM refers to the scaffolding of a company's QM outside of its existing boundaries along the SC (Sharma and Modgil, 2015; Huo et al., 2016). Robinson and Malhotra (2005, p.319) defined SCQM as "the formal coordination and integration of business processes involving all partner organisations in the supply channel to measure, analyse and continually improve products, services, and processes in order to create value and achieve the satisfaction of intermediate and final customers in the marketplace". A more recent definition, suggested by Zhang et al., (2017), defines SCQM as the formal coordination of the business process, which involves every company in the SC creating value and satisfying customers.

Previous studies in SCQM can be classified into three main categories. The first category defines SCQM and demonstrates the rationale and synergy behind QM within SC practice such as in Foster and Ogden (2008) and Flynn and Flynn (2005). The second category

involves developing SCQM frameworks. This type of study reviewed the previous literature and developed frameworks for SCQM without empirical implementation. These frameworks either considered QM and SC factors as separate components like in Zhong et al., (2016), Faisal et al., (2011) and Prajogo et al., (2012), or considered the SCQM factors as one component, in which QM and SC practices are embedded together such as in Sampaio et al., (2016) and Foster (2008). The third category is the empirical studies that have been conducted in different countries and sectors, such as in Song et al., (2017) and Soares et al. (2017). Companies face challenges in the implementation of SCQM, due to difficulties in information sharing, trust, and building integration within their SC (Sampaio et al., 2016). Lin et al., (2013, p.360) emphasised that "a key challenge to modern supply networks is for lead firms and their channel partners to evolve from their internally process-oriented quality management to a supply-chain based and quality-centred system". This foundation has triggered the concept of having quality-centric systems embedded across a supply chain network, through achieving SCQI as the main practices toward applying the holistic SCQM (Huo et al., 2014).

2.2 Framework development

This section extracts the framework of the role of AC process into SCQI from the previous literature, as shown in Figure (1).

----------Insert Figure 1 Approximately Here----------

This study digs deep into exploring internal and external quality integration by investigating the specific components of SCQI that were extracted from the SCQI and supply chain integration (SCI) literature, as presented in Table (1).

----------Insert Table 1 Approximately Here----------

The next section discusses the main themes through two main terminologies: supply chain quality integration and absorptive capacity.

2.2.1 Supply chain quality integration

Previous research has suggested that a stringent quality integration within the SC network and outside a single company's boundaries should be taken into consideration when designing a SC (Collin et al., 2009; Zhang et al., 2017). This kind of integration is often referred to as supply chain quality integration (SCQI) (Huo et al., 2016). The application of

SCQI allows for both continuous processes and products' improvement in the SC in order to enhance both financial and operational performance (Zhang et al., 2017; Zhong et al., 2016). SCQI requires companies to integrate their quality related knowledge within their SC, by enabling their members to access and share this specific knowledge (Malhotra et al., 2005; Revilla and Villena, 2012). Henceforward, a number of studies have concluded that SCQI is the basic component that enables companies to build their SCQM (Huo et al., 2014; Zhang et al., 2017).

The concept of SCQI is rooted in SCI practices and SCQI extends the SCI concept from the fundamentals of quality requirements and principles. It is accepted that SCQI focused on managing the flow of products, services, money and decision-making (Huo et al., 2014; Chang et al., 2016; Flynn et al., 2010), through a synthesis of internal and external integration, in order to continuously improve the quality of processes and products (Zhang et al., 2017). Furthermore, Huo et al., (2014,p.39) defined SCQI as "the degree to which an organization's internal functions and external supply chain partners strategically and operationally collaborate with each other to jointly manage intra- and inter-organizational quality-related relationships, communications and processes, with the objective to achieve high levels of quality-related performance at low costs".

The core constructs of SCQI consist of three specific dimensions, namely internal, supplier and customer quality integration (Huo et al., 2014). Supplier quality integration and customer quality integration refer to external quality integration, which is the degree to which the company integrates with its suppliers and customers to give structure to its inter-organisational strategies and practices, as well as synchronised quality-related activities that fulfil the customers' quality requirements (Huo et al., 2014). Supplier quality integration focuses on three main themes :i) procurement strategy-building a procurement strategy is important, due to its impact on the production process and is responsible for approximately 60% of a company's total costs (Degraeve and Roodhooft, 2001). Paulraj et al., (2006) stated that strategic procurement impacts the supply integration level, in addition to its impact on buyer and supplier performance and is in a better position to levy a better relationship with suppliers; ii) supplier development - it improves the quality, delivery and flexibility, and overall manufacturer performance (Krause et al., 2007). However, supplier development requires additional operational support over time (Busse et al.,2016); iii) Supplier involvement - building closer ties with suppliers enables companies to benefit from suppliers' capabilities to improve their products, resulting in supplier integration in regards to

knowledge acquisition of suppliers, new technologies, collaborative decision-making, resulting in product and process improvement (Bartlett et al., 2007). Supplier involvement often improves the decision-making process, by providing companies with new knowledge and SC design (Sharifi et al., 2006; Dunlap et al., 2016). It is intriguing to note that customer quality integration also contains three overarching themes: i) Customer complaints - improving product and service quality will reduce customer complaints and ultimately improve customer satisfaction (Cho et al., 2003). In addition, complaint management is an integral part of customer integration, which consists of customer complaints, relationships and satisfaction (Ayoub et al., 2017); ii) Customer involvement - it refers to market complexity and changes in customer requirements, often encouraging companies to more closely involve their customers in the process of engineering and managing their purchasing strategy (Flynn et al., 2016). Companies more often invite customers to validate their products and services, whilst they generate the knowledge required to develop products in new markets. Such customers are involved in the knowledge transformation processes and have become more integrated in product development process (Sigala, 2012); iii) Logistics integration - it involves sharing resources and coordinating activities that have become embedded in the SC and represent the company's competitive advantage. This integration occurs through internal logistics integration across functions, as well as the integration of logistics activities across the SC (Prajogo et al., 2016), such as increasing the transparency of inventory management, vendor relationships, transportation, distribution, warehousing and delivery services (Tan, 2001).

Applying the incentives of integration, Zhang et al., (2017) focused on internal quality integration, relating to the quality-related process within the company's internal operations and functions. They suggested that internal quality integration facilitates the quality process to fulfil customers' requirements, often through cross-functional quality management along with quality teamwork supported by quality activities and problem solving (Zhang et al., 2017; Huo et al., 2016). However, without such cross-functional integration any improvement process is impossible, as it is difficult to implement without bringing together the different departments (Bardhan and Pattnaik, 2016). Additionally, Danese et al.,(2013) stated that cross-functional quality integration could enhance communications between customers and suppliers and improve SC responsiveness. Cross-functional transparency principles will enable firms to improve their products' design and quality, as well as their processes' efficiency by minimising quality-related problems (Huo et al., 2014). One of the

consequences of the SCQI thinking is the questioning of companies' roles and abilities to absorb SC knowledge in order to enhance SCI and SCQI (Blome et al., 2014; Eckstein et al., 2015; Huo et al., 2014). Consequently, the next session will discuss this absorptive capacity concept.

2.2.2Absorptive capacity

The importance of integrating buyer-supplier knowledge has become an important factor for SCI in order to adapt and change according to the markets (Saenz et al., 2014). Integrated knowledge within a SC enables members to access, share and exploit knowledge, as well as create new knowledge (Azadegan, 2011). For example, Gebauer et al., (2012) emphasised that the way a company combines its capabilities with the learning process is more valuable than a large amount of unutilised and/or inaccessible external knowledge. There are a number of studies that have identified AC as a major factor impacting a firm's ability to create knowledge through acquisition, assimilation, transformation and exploitation (Lichtenthaler, 2016; Zahra and George, 2002). Furthermore, Cohen and Levinthal (1990) highlighted that a firms ability to exploit external knowledge is subject to three main factors: i) recognising the value of new knowledge, ii) assimilating it, and iii) applying it for commercial ends.

To explore these important characteristics,we have adopted Zahra and George's (2002) AC framework. Zahra and George (2002) highlighted that AC consists of potential and realised AC. This potential AC includes: i) Knowledge acquisition – it is defined as the process of obtaining new and useful information through generating, developing, and building knowledge (Daud and Yusoff, 2010). This knowledge creates a paradoxical situation and pushes a company to change as well as adapt to its new situation (Valkokari and Helander, 2007); ii) Knowledge assimilation - it usually refers to companies' routines and activities, which help in analysing, explaining, and understanding externally acquired knowledge (Zahra and George, 2002). For example, a company's existing knowledge does not change through assimilation; however, new knowledge may only be combined with the current cognitive structures (Todorova and Durisin, 2007). On the other hand, realised capacity focuses on two attributes. The first being the knowledge transformation ability, where a company's routines are refined through existing knowledge or new knowledge or adding, eliminating or even interpreting knowledge in a different way (Zahra and George, 2002; Todorova and Durisin, 2007) and secondly, the exploitation, which is the utilisation of knowledge after acquiring, assimilating, and transforming knowledge. Exploitation also allows companies to create,

develop, or even exploit new competences, routines, processes and products (Zahra and George, 2002; Xie et al., 2018).

2.3 Theoretical background: Dynamic capability

In general, dynamic capability theory identifies capabilities in a dynamic and uncertain environment, wherein a company needs to adopt and integrate its resources and capabilities with a view to cope with environmental changes (Chowdhury and Quaddus, 2017; Brandon-Jones et al., 2014). Thus, the argument of creating value from resources is extended to dynamic capability, which is defined as companies' abilities to integrate, adapt, and reconfigure internal and external competencies, with a view to respond quickly to environmental changes (Teece et al., 1997). Dynamic capability theory assumes that companies should not only have strong resources, they should also have a routine where they renew these resources through sensing, seizing and reconfiguring (Teece et al., 1997; Teece, 2007). In other words, it is more important for a company to create value from its resources, rather than knowing who won and controls the resources (Son et al., 2014).

Previous studies have considered the learning process as a way to achieve dynamic capabilities and that AC is the learning component of the dynamic capabilities, via scanning, specifying, and assessing the value of external knowledge and accumulating important knowledge (Laursen et al., 2010; Tsai, 2001). Hence, the AC process systematically shapes routines by combining behaviour and cognitive processes, which articulates and codifies internal knowledge while facilitating the absorption of external knowledge (Zollo and Winter, 2002; Bustinza et al., 2010; Halldórsson et al., 2015). We argue that AC has a role in SCQI, which leads to creating dynamic capabilities via creating, extending, and modifying companies' resources.

3. Methodology

This study adopted a multiple case study strategy through replication, which facilitates the understanding of causality (Creswell, 2013; Yin, 2014). The adoption of multiple cases can lead to avoiding misjudging events by providing a triangulation mechanism (Eisenhardt, 1989). A multiple case study enables us to use data to explain the complexity of real situations (Zainal, 2007).

3.1 The case of the pharmaceutical industry

Faced with more and more global challenges, pharmaceutical manufacturers are shifting their focus towards the developing markets, with a goal to find new sources of revenue and profit. Therefore, developing markets are expected to sustain the growth of the global pharmaceutical industry and account for approximately one-third of the global pharmaceutical trade (Buente et al., 2013). Jordan is one of the leading developing countries in generic pharmaceutical manufacturing and trading where 70% of the industry's production is exported all over the world (Central Bank of Jordan, 2016). Furthermore, Jordan is one of the largest trading partners of the European Union, accounting for 16.9% of its trade in 2015, above Saudi Arabia at 15.3% and China at 10.5% (European Union, 2017). However, the Jordanian pharmaceutical industry, as well as the pharmaceutical industry in other developing countries, suffer from inconsistent quality levels in different markets (World Health Organisation, 2009; Rehman et al., 2015).

3.2 Data collection

The data was collected in two rounds over a 6 month period, with a total number of 54 interviews, from seven companies, referred to as company A, B, C, D, E, F and G.

The first round, composed of 18 semi-structured interviews, was necessary to build a detailed understanding of the main quality issues faced by the pharmaceutical industry. In this round, senior and middle managers of quality and supply chains were interviewed, who in turn also suggested other potential relevant participants (snowball technique) (Saunders et al., 2016). The set of data was generated from three major pharmaceutical companies in Jordan. Guided by the findings and outcomes from the first round, the second round was designed to generate more in-depth data. This round aimed to understand the AC process and its role within the SCQI practices. 36 participants from the seven companies had taken part. The objective behind the selection was to gather information from different companies who operate in different countries. The focus was on the following departments and functions: supply chain, quality, research and development, marketing, and production; as based on the first round interviews, those departments were the most knowledgeable in answering the study's questions.

Each interview lasted between 40 minutes and 90 minutes. All the interviews were transcribed and translated into English to ensure construct validity (Yin, 2014). Additionally, follow-up telephone interviews were held as necessary to clarify any imprecise information

arising from the interviews. The data collection stopped when we reached a level of saturation (Saunders, 2012).

3.3 Data analysis

For the data analysis, we followed the template analysis technique. The analysis generated a coding structure to represent the themes in a meaningful manner, in line with the literature that was reviewed (King, 2012; Braun and Clarke, 2006). Absorptive capacity, internal quality integration, supplier quality integration and customer quality integration were the main themes established. Table (2) summarises the four main themes and their taxonomy.

----------Insert Table 2Approximately Here----------

The data analysis process focused on the similarities and overlap of the implementation between respondents in each company. In addition, this study's analysis has taken into consideration the entire dataset, regardless of their frequency of appearance, in order to fully address the research questions. This is supported by Braun and Clarke (2006, p.82), who wrote that "the 'keyness' of a theme is not necessarily dependent on quantifiable measures but rather on whether it captures something important in relation to the overall research question".

In order to reduce bias in the case and the cross case analysis, the coding process was conducted by the authors sequentially using Nvivo, where the different authors alternately checked the meaning of the coding and amended it accordingly for assuring a certain level of consistency in its interpretation.

4. Results

4.1 First round results

The first round presents the quality challenges that global pharmaceutical supply chains in a developing market are facing. We found that managing quality is critical and greatly influences different companies' activities, such as production, marketing, and sales. All of the case companies follow good manufacturing practices (GMP) as a guideline for quality implementation. Therefore, quality control and quality assurance are involved in every step of both production and supply chain. Despite these facts, these pharmaceutical companies face problems in the quality of their products and processes. This is evidenced by the number of quality complaints and the high number of returned medicines associated with production error. Thus, the case companies experience a high amount of production waste, frequent

production interruptions, delays with the raw material delivery, variation in the quality of raw materials, and long suppliers' lead times. The supply chain manager of company A elaborated:

> *"Suppliers change the raw materials' specifications without informing us. This causes problems with the products and increases customers' complaints and returned medicines. For some products, it is very hard to find a suitable supplier and this impacts our ability to satisfy the markets' needs".*

Moreover, we found that the case study companies lack effective and efficient ways of utilising external knowledge. The quality manager of company C said: *"When we produce a product for the first time, it costs us a lot, and creates a lot of waste to correct the defects, mainly because of our employees' knowledge differences"*. This shows the inability that companies have to capture and manage knowledge. These problems lead to a high volume of customer complaints and returned medicines, impacting directly firms' performances. These issues directed the study towards understanding the importance of the AC process in SCQI practices.

4.2 Cross case analysis

This section compares and contrasts the findings across the seven cases. Table (3) contains samples of quotations from respondents.

----------Insert Table3Approximately Here----------

Table (4) summarises the cross case analysis.

----------Insert Table 4Approximately Here----------

4.2.1 Internal quality integration

In the majority of cases (A, B, C, D, and F), quality is built on the industry's requirements, such as GMP and the markets' requirements. Therefore, these companies have a non-standardised quality protocols that depends on what the markets require. On the other hand, case companies E and G achieved a more consistent quality, by implementing quality by design. Case companies E and G have implemented a quality by design concept that builds the quality attributes of the products and processes in advance, instead of waiting for the

problem to occur and then take the appropriate actions. Company E goes even further and implemented a quality risk assessment to identify the risk of possible interactions between the materials, product attributes, and different departments. The risk assessment is classified based on previous experiments and in collaboration with the SC. Moreover, company E has a quality team who assesses and follows up on quality implementation in all of the company's sites, in order to maintain a standard level of quality implementation.

Internal quality implementation impacts how the functions deal with each other. For example, when company E implements a certain internal quality protocol, it impacts the R&D formula, the production process, the analysis techniques, and the responsibility of each department. For example, the designed quality organises the internal quality integration in companies E and G, whereas the internal quality integration is organised according to the GMP only in the remaining companies.

The findings show that all companies' functions are integrated with each other in their routine work; however, companies B, C, D and F do not share common goals between departments, where each department works independently to achieve their goals. This causes conflicts between departments and leads to increasing costs and time in completing tasks. However, the results indicate that only company's functions in cases A, E and G have regular meetings and assessments in order to share goals and help each other to achieve them. In the event of urgent problem solving, all companies' quality departments investigate the issues with the responsible department, who work together to solve problems. Moreover, the findings show that companies A, B, C, and F implement quality through quality assurance and control.

4.2.2. Supplier quality integration

In each of the seven cases, the internal quality integration impacts both the purchasing strategy and suppliers' selection. For example, the purchasing strategy and suppliers' selection in companies A, B, C, D, and F depends on the materials' specifications, which the R&D manager identifies based on the GMP and the markets' requirements. Hence, the materials' specifications change according to the different qualities in each market. Companies E and G further refer to the designed quality in selecting suppliers who are able to help the companies work within the requirements.

The companies also encountered different levels of involvement with suppliers, depending on the reasons behind involving suppliers. Companies A, B, and D have a minimum level of suppliers' involvement (taking production suggestions on board and sharing the drug master

file). Companies C, D, and F involve suppliers much further by outsourcing production of some of their products, know-how and patency issues. Companies E and G take this even further by outsourcing some of their key products in order to penetrate markets faster while finishing medical registration procedures.

Another practice of supplier involvement was observed when companies collaborate with their suppliers to build quality in the products and processes in order to reach the required design. In this case, a partnership might be formed, where a percentage of the sales is redistributed between the companies, this is called a "royalty right". This type of agreement is found in companies D, E, and G in different levels. A royalty right is a win-win relationship between suppliers and manufacturers, where the suppliers give the manufacturers the know-how and the manufacturers produce the products for a certain percentage of sales that go to the suppliers. Companies E and G also undertake a continuous training with key suppliers; this helps them to improve their production process, by reducing the number of raw materials used in the coating stage. Company E works further with key suppliers through co-projects to develop new products, whereas company G conducts bioequivalent tests when it produces the originator medicine.

Suppliers' evaluation in companies A, B, and C follow certain criteria, such as delivery, cost and quality. The focal firms assess these criteria after each shipment. Companies D and F rely mainly on evaluating the certificates presented by the suppliers. Moreover, Companies C, E, F, and G regularly evaluate their suppliers through visits.

4.2.3 Customer quality integration

Companies A, B, C, D, and F reactively deal with customers' complaints through the quality departments who take the lead in resolving complaints. These companies considered customer complaints as a key integral part of their ongoing initiatives relating to continuous improvement. Nevertheless, companies E and G proactively deal with customer complaints by considering the market requirements and risks when they design for quality. Therefore, the designed quality is used as a reference to trace the complaints and resolve the related issues. Moreover, company E has a dedicated centre to deal with complaints in order to ensure that they are resolved quickly, suitably and in a standard manner.

Markets' requirements and preferences impact product design and packaging. For example, the North African markets prefer sachet medicine, while other markets prefer tablets. The designed quality in companies E and G identifies the nature of customers' involvement, either

at the beginning to determine the quality attributes, or later for improvement. In addition, company E involves its customers from all over the world to select its future pipeline.

Companies are keen to select trusted customers who have a good reputation, strong distribution capabilities, and a solid financial position. Companies E and G select customers who are able to implement their company's quality criteria when dealing with the products. To build good relations with key customers, all the companies sponsor medical conferences and conduct free academic workshops for key local doctors, who must obtain a certificate indicating that they conducted academic training in order to renew their licenses.

Company G provides training and lectures to its key agents to improve their medical knowledge, which helps them to deal with their products and reduce mistakes. On the other hand, company E provides this service differently. They prefer involving key doctors, pharmacists, and agents from all over the world, not only to help them renewing the licences and promoting the company's products, but also to improve the doctors, pharmacists, and agents' abilities to deal with the medicines and write accurate prescriptions, so complaints and errors are minimised.

All these companies produce for external markets based on confirmed orders to reduce the finished product storage costs and to avoid the risk of product obsolescence. Companies A, B, C, D, and F keep large stocks of raw materials to reduce shipping costs and reach the minimum acceptable order. Furthermore, all companies use data logger devices to check medicine quality during the shipment journey. In addition, the medicines' quality characteristics, as mentioned by case companies A, D, E, F, and G influence the transportation modes. For example, airfreight is suitable for some types of medicines, but not suitable for others.

4.2.4 Absorptive capacity

Companies A, B, C, and F acquire mandatory knowledge from their suppliers, such as product master files, which are required to register the medicine and deal with the materials, as well as deal with suggestions when companies face problems. Companies D, E, and G go further and acquire production knowledge from suppliers through technical transfer, license, and training. The knowledge acquired from customers, on the other hand, are mainly complaints, market trends and feedback, as it is with companies A, B, C, D, and F. However, companies E and G acquire more strategic knowledge from customers to build their quality and develop new products. The acquired knowledge from the SC is transferred and

assimilated through meetings between the head of departments, as in the cases A, B, C, E, F, and G. In companies A, B, C, D, and G, knowledge is assimilated through training to ensure that the employees have the required level of knowledge and understanding. Additionally, company E creates a specific project, led by the initiator department, to assimilate the strategic knowledge and put forward a plan of action.

All companies rely on documents, such as standard operations procedures (SOPs) in the case of new procedures, or corrective and preventive action (CAPA) in the case of amending existing procedures. In addition to, the drug master file especially for the knowledge related to the formula. These documentations enable them to create a work routine between departments. However, companies A, B, C, D, E, and F depend mostly on informal ways to assimilate knowledge and create the required level of understanding between employees, especially when the departments work together in the factory to produce the products, since some knowledge is difficult to produce in written form.

Companies A, B, C, and F exploit suppliers' knowledge by utilising the knowledge of the drug master files, which explains how to deal with the raw materials, as well as utilise suppliers' suggestions in improving the processes and solving problems. Companies D, E, and G exploit strategic production knowledge from suppliers, which shortens the timescale of the products' development. This knowledge leads towards producing new products, for example, 10%, 40%, and 20% are the percentage of companies D, E, and G total production from acquired knowledge. This is in addition to improving the process through training and expert exchange in companies E and G.

Furthermore, companies E and G rely on the knowledge acquired from suppliers to design the quality space. As they need to conduct many experiments to reach the desired quality space that allows them to produce without error and near the target. Hence, the bulk of the utilisation of suppliers' knowledge for the companies is at the beginning of the production process. Customer knowledge, on the other hand, is utilised by improving the products and processes in companies A, B, C, D, and F, whereas companies E and G utilise customer knowledge to build the products' quality attributes. Finally, companies B and D develop new products from their customers' suggestions, as long as they have the knowledge and the ability to utilise them.

5. Discussion

5.1 How and to what extent do pharmaceutical manufacturers implement SCQI practices to improve the quality of their products and processes?

The increase in global competition and the increase in quality problems within the pharmaceutical SC have both affected how companies manage and design their SC (Yu and Huo, 2018). Furthermore, quality related issues within the SC have inspired practitioners and decision-makers to focus their efforts towards extending their quality programmes implementation within their SC network (Soares et al., 2017). However, the question relating to how SCQI is implemented remains inconclusive within the extant literature (Zhang et al., 2017). Consequently, the analysis of this study shows that the majority of the pharmaceutical manufactures implement a number of SCQI practices through their internal quality and in function of the industry and market requirements (as shown in Table 4).

The traditional focus on quality control and assurance are useful for companies in terms of increasing customer satisfaction, reducing complaints and reducing waste (Jraisat and Sawalha, 2013). However, quality assurance and control are a very traditional style of quality management and are limited to specific quality checks and inspections (Fotopoulos and Psomas, 2009). This paper presents a cross case analysis that demonstrates that few companies are now implementing quality through the quality by design concept (only Company E and G as shown in Table 4). Quality by design enables companies to build their processes and products quality in advance, as opposed to reacting to the problems once occurred (Dong-Hua and Zailani, 2011; Juran, 1992). Furthermore, it changed the quality concepts, from producing in different quality levels within standards to meet different market needs, to producing near the optimal target values, with minimal errors (Gygi and Williams, 2012), as shown in Figure (2). The modern view of quality focuses on consistent quality around the designed target to reduce costs and waste (Gygi and Williams, 2012; Prashar, 2014). Therefore, quality by design in the pharmaceutical industry offers the companies self-regulated flexibility, with tight quality standards and real-time drug production (Pramod et al., 2016).

----------Insert Figure 2 Approximately Here----------

The results show that the implementation of the traditional quality perspective is due to a lack of quality culture and lack of understanding in terms of quality's nature and implementation, since the majority of the respondents consider quality as implementing the GMP's requirements. For example, Table (4) shows that only three companies share the goals across

functions, whereas all companies' functions are integrated while doing the routine work. As a result, the majority of the case companies suffer from quality inconsistencies. Faisal et al., (2013) considered quality culture as the dominant component of successful quality implementation, which improves a product's reliability and reduces errors and customer complaints. The findings reveal that internal quality integration is a prerequisite to external quality integration. This is consistent with previous studies that agreed on the importance of internal quality integration with external quality integration, but did not explain how this process occurs (Huo et al., 2016; Flynn et al., 2010). The results further demonstrate that the internal quality system and integration help companies in sustaining the quality of their products and processes within the SC, which is the foundation for developing strong relationships between firms. For instance, companies select suppliers that can meet their quality requirements, develop strategic partnerships with them, and to support companies' purchasing strategy. In addition, companies evaluate suppliers based on their ability to maintain the main production processes within the designed space, as well as in reaching their desired quality design through co-projects, as presented in Table (4).

Moreover, when companies only follow the industry's requirements as quality system, they primarily select suppliers, evaluate them, and identify the materials' specifications according to these requirements. This is clear in Table (4) where the majority of companies follow this approach and deal with their suppliers according to industry and markets' requirements. As summarised in Table (4) for example, the companies that design for their quality proactively deal with complaints by referring to the designed quality in the case of complaints from customers to trace explanations and solve issues. Moreover, these companies select customers who are able to preserve their quality and train them to reduce mistakes resulting from incorrect ways to deal with the medicines, as well as involve them in identifying the quality attributes. Furthermore, they manage logistics in a way that supports their internal quality in terms of integrating with distributors to ensure the storage condition is suitable for the products, minimise stock, improve customers' performance to minimise errors, and further select the most suitable transportation method to preserve product quality. On the contrary, the companies who simply adopt the industry's requirements as their internal quality system deal with customers according to these requirements. In this case as shown in Table (4), companies react to complaints when they occur and do not check their distributors' storages condition because it is not required by the regulations.

In summary the cross cases analysis show that companies implement SCQI through two main approaches. First, the traditional approach that follows and uses the industry and the markets' requirements to identify the internal quality, which in its turn affects the way the companies will manage their external quality integration with suppliers and customers. Alternatively, the second approach that reveals the importance of implementing the quality by design in managing the external quality with suppliers and customers.

In terms of to what extent the pharmaceutical manufacturers implement SCQI; the results show that the majority of the companies adapt the first approach. Therefore, they suffer from quality inconsistency as they constantly change and adjust their internal and external quality integration according to the industry and markets' requirements. Moreover, the results indicate that the pharmaceutical manufacturers have better quality integration with their customers than with their suppliers. For example, companies improve the quality of their products according to their customers' feedback and complaints. On the other hand, the majority of pharmaceutical manufacturers integrate partially their systems with their suppliers to improve the quality of their products and processes. The predominant nature of the relationship between manufacturers and suppliers is based on sourcing the raw materials.

5.2 How and to what extent can the processes of AC be implemented within pharmaceutical manufacturers to facilitate the concept of SCQI?

The results show that the AC process plays an important role in SCQI practices when acquiring, assimilating, transforming and exploiting strategic and operational quality related knowledge. It significantly impacts companies' internal quality integration, as shown in Figure (3). The processes of AC can be implemented within the pharmaceutical manufacturers to facilitate the SCQI practices through their significant importance in the companies' internal quality integration.

The companies rely on the knowledge of their suppliers and customers to implement quality and reach a design space where the companies can produce without error. Therefore, the case analysis shows that companies who design the quality of their products and processes need to exchange more knowledge within their SC in order to reach the desired quality. Qi et al., (2017) mentioned that companies with a high level of AC have the ability to learn from SC partners, which facilitates the implementation of the supply chain's strategies. Hence, companies with AC benefit from integration related knowledge acquired from customers and suppliers to create value (Fynes et al., 2015). Moreover, the results demonstrate the

importance of AC, even in implementing traditional quality in the pharmaceutical manufacturers, since the companies need to absorb the SC knowledge to satisfy the industry and the markets' requirements. Huo et al., (2014) mentioned that internal quality integration supports companies' quality by improving their abilities to learn from external partners. The present study also explains the importance of the AC process in inspiring companies to integrate with their suppliers and customers to sustain the quality of their products and processes.

----------Insert Figure 3 Approximately Here----------

Nevertheless, the results as summarised in Table (4) indicate that the pharmaceutical manufacturers do not have suitable AC processes, since the majority of the companies acquire operational knowledge, such as knowledge related to the medicine registration, according to both the authority bodies and GMP. In addition to some suggestions from the supplier's side, in the case of problems in raw materials and processes, the companies highly depend on complaints, customer feedback, and the agents' sales expectations from the customers' side. Furthermore, a few companies have started to acquire and absorb strategic knowledge such as company E and G as in Table (4), which helps them enter new markets much faster, and helps them add new products to their production line. For instance, Table (4) indicates, the majority of the knowledge absorbed is reflected by improving the existing products and processes, whereas only few companies can absorb external knowledge to develop new products and processes. The lack of AC process awareness, leads to a less updated pool of knowledge and experience, which in turn negatively affects the companies' abilities to absorb new knowledge in the future (Dobrzykowski et al., 2015). Moreover, the pharmaceutical manufacturers highly depend on informal discussion to assimilate new quality related knowledge, in which only the actions that are taken are documented and transformed. This leads to a loss of important knowledge that might be used in the future.

Overall, the results demonstrate the importance of AC processes in building the internal quality and facilitate SCQI. This happens through supporting the two approaches of SCQI, as explained in the first research question section (5.1). In that sense, companies acquire strategic and operations knowledge, assimilate, transform, and exploit this knowledge in building and enhancing the internal quality system, which affect the external quality integration.

In terms of to what extent the AC processes can be implemented to facilitate the concept of SCQI. The study shows that the majority of companies acquire operations knowledge from

suppliers and customers, which is essential to apply the industry and markets' requirements. In this case, AC processes help in the traditional SCQI. Few companies have started to acquire and exploit strategic knowledge that enhances quality by design and support the SCQI. Thus, companies started to move toward an advance implementation of SCQI that depends on a robust internal designed quality, affecting the external quality integration.

6. Conclusion

This paper's main contribution extends the use of SCQI through the adoption of AC within pharmaceutical manufacturers. The paper shows that the majority of the pharmaceutical manufactures implement SCQI practices through their internal quality and in the function of the industry and markets' requirements. The study also highlights the existing knowledge gap regarding SCQI practice, despite being a fundamental component of SCQM. Furthermore, the paper contributes to the role of AC in facilitating SCQI practices, specifically how quality should be embedded within the SC network in order to achieve continuous improvement within a SC and how AC is conceptualised through the interface of SCQI.

This paper goes beyond the dyadic perspective through theoretical and empirical contribution. The study highlights the importance of building strong internal quality integration and explains how decision-making and know-how impacts the quality of the products and the processes within the SC. Therefore, companies improve their abilities to absorb knowledge from their SC partners and exploit this knowledge in successful quality integration with both suppliers and customers. This type of integration is a solution for the limited resources that companies have, wherein they can expand their resources through integration with suppliers and customers. It should be stressed that quality does not work within the specifications and the standards, instead, quality works on target with minimum variation. There is an argument that SCQM has become an issue in terms of enhancing performance within the SC (Zhong et al., 2016). This study explores the role of AC process through acquisition, assimilation, transformation and exploitation to improve the SCQM, whilst considering the synthesis of internal and external quality integration (Huo, 2014, Zahra and George, 2002) across a pharmaceutical SC network. For example, pharmaceutical manufacturers companies need effective AC process to develop successful SCQI practices and improve operational performance. Hence, the study presented the paths and the processes that improve competences, where the previous studies that used dynamic capability theory

fall short to identify (Chowdhury and Quaddus, 2017). In addition, this study presents the validity of employing, sensing and seizing opportunities and reconfiguring resources in creating commercial value through improving the quality of pharmaceutical manufactures' products and processes in a developed and a developing country.

Whilst this study extends the use of SCQI through the adoption of AC within pharmaceutical manufacturers, a number of limitations remain, which might open up opportunity for future research. First, we acknowledge that the focus was exclusively on pharmaceutical manufacturers; hence generalisation to other sector is not appropriate at this stage. Having said that, we are confident that the results could be extrapolated other pharmaceutical companies. Second, due to its qualitative nature the study does not allow to measure the impact that internal quality integration has onto the firms' performance, therefore we would recommend to design a quantitative study to test these relationships. Finally, we believe that it would be worthwhile for future studies to explore the role of AC processes within SCQI practices in the service industry and compare these results with this present study.

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Figure 1 The developed framework of the role of the AC processes into supply chain quality integration

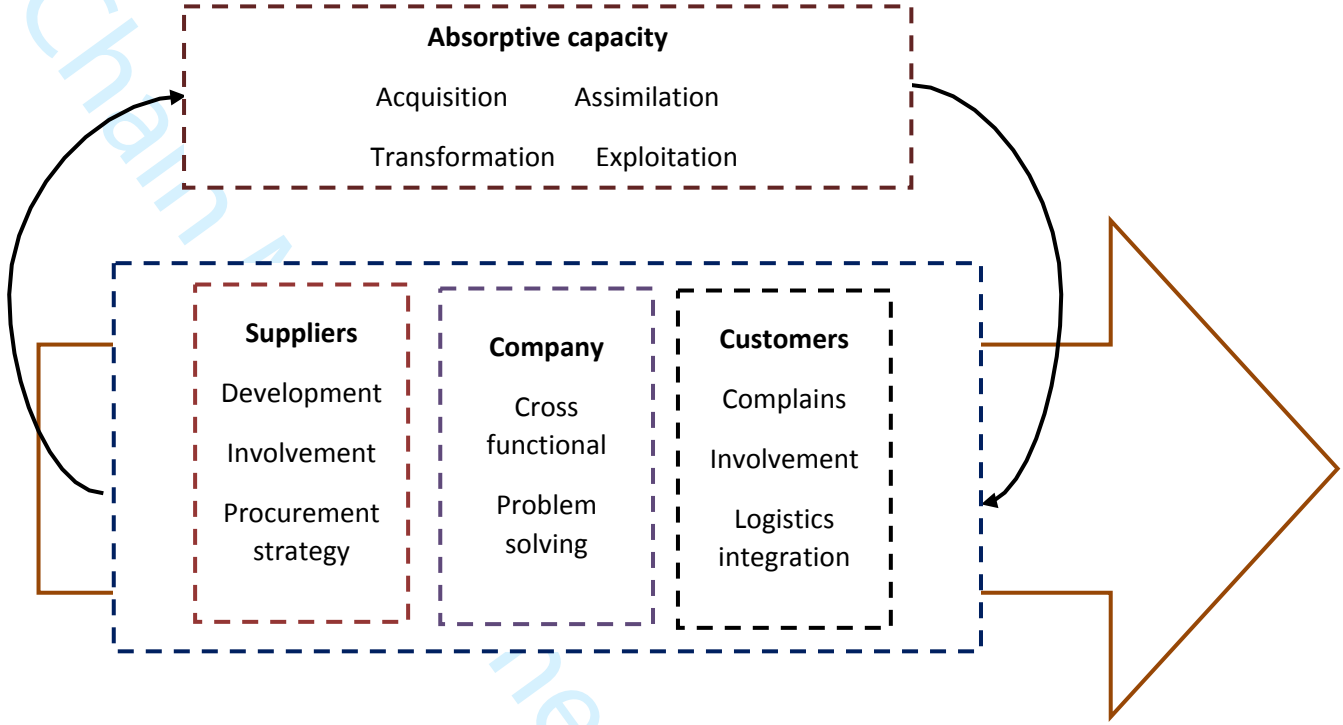
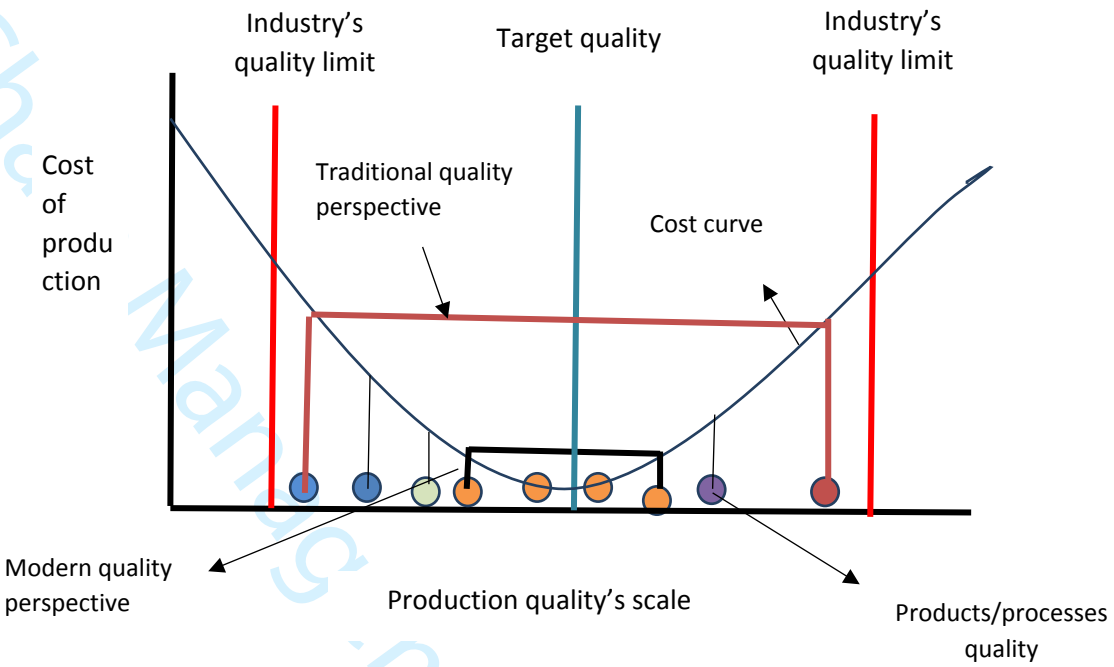


Figure 2 Comparison between the traditional quality and the quality by design



Adapted from: Gygi and Williams (2012)

Figure 3 The role of AC process within SCQI practices

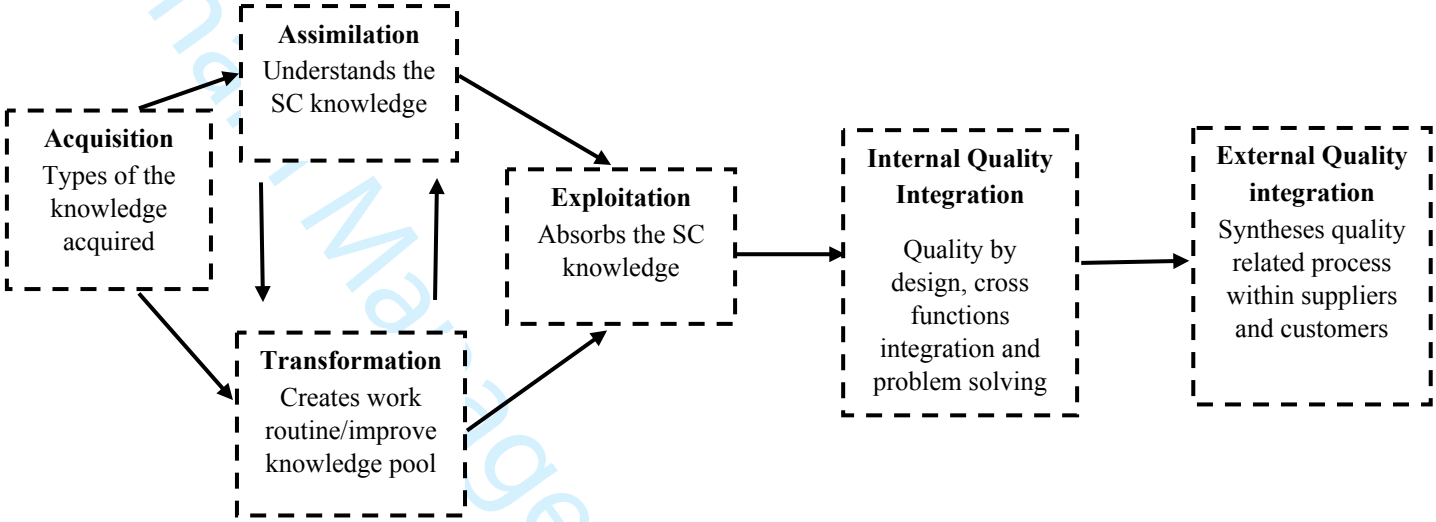


Table1 SCQI's Components

	Supplier integration			Internal integration		Customer integration		
Ref	Procurement	Involvement	Development	Cross functional	Problem solving	Complaints	Involvement	Logistics
Yu and Huo (2018)		X	X	X	X		X	
Golini et al., (2017)		X		X		X	X	
Ayoub et al. (2017)		X		X		X	X	
Tan et al., (2017)		X				X	X	
Turkulainen et al. (2017)				X	X			
Yu et al. (2017)		X	X			X	X	
Qi et al. (2017)		X	X	X		X	X	
Zhang et al. (2017)		X	X	X	X	X	X	
Lee et al., (2016)	X	X		X			X	
Huo et al., (2016)		X	X	X	X	X	X	
Lii and Kuo (2016)	X	X	X	X		X	X	
Prajogo et al. (2016)								X
Flynn et al., (2016)		X	X	X	X		X	
Huo et al., (2016)		X	X	X		X	X	
Kaliani et al., (2016)	X	X	X			X	X	
Cheng et al. (2016)		X		X			X	
Lee et al. (2016)	X	X		X			X	
Tseng and Liao (2015)		X		X			X	
Danese and Bortolotti (2014)		X		X	X		X	
Huo et al. (2014a)		X		X			X	
Xu et al., (2014a)		X	X			X	X	
Beheshti et al. (2014)	X	X		X				
Seo et al., (2014)	X	X		X		X	X	
Mellat-Parast and Spillan (2014)								X
Huo, et al. (2014)		X	X	X	X	X	X	
Liu et al., (2013)							X	
Droge et al. (2012)	X	X	X					
Wong et al. (2011)	X	X		X			X	X
Boon-Itt and Yew Wong (2011)	X	X		X			X	
Flynn et al. (2010)	X	X	X	X		X	X	

Table 2 Main study's themes taxonomy

Themes	Sub-themes	Sub-sub-themes
1.Absorptive capacity	1.1 Knowledge assimilation	1.1.1 Techniques to understand the external knowledge
	1.2 Knowledge exploitation	1.2.1 Create commercial value from SC knowledge
		1.2.2 Reasons that hinder companies to utilise SC knowledge
	1.3 Transformation	1.3.1 Method to create work routine
	1.4 Knowledge transfer method	1.4.1 Methods to transfer the knowledge with SC
	1.5 Knowledge acquisition	1.5.1 Types of SC's knowledge acquired
2. Internal quality integration	2.1 Internal collaboration for QM	2.1.1Departments working together for QM implementation
		2.1.2Internal collaboration to achieve goals
	2.2 QM enablers	2.2.1Continuous improvement
		2.2.2 Empowerment
		2.2.3 Top management support
	2.3QM perception	2.3.1Customer satisfaction
		2.3.2 Industry's standards
		2.3.3 Quality department's role
		2.3.4 Quality by design
	2.4 QM problems	2.4.1 Different quality in different market
		2.4.2 Lack of quality culture
		2.4.3 Sourcing problems
		2.4.4 Machines problems
	2.5 QM problem solving	2.5.1 Problem-solving team
		2.5.2Collaboration for problem-solving
3.Supplier quality integration	3.1 Procurement	3.1.1 Procurement policy
	3.2 Supplier development	3.2.1 Development practices
	3.3 Supplier evaluation	3.3.1 Evaluation practices
	3.4 Supplier involvement	3.4.1 Involvement techniques
	3.5 Supplier selection	3.5.1 Selection criteria
4.Customer quality integration	4.1 Customer complaints	4.1.1 Complaints issues
	4.2 Customer involvement	4.2.1 Involvement nature
	4.3 Customer selection	4.3.1 Selection criteria
	4.4 Logistics integration	4.4.1Practices the companies do to manage the products' quality
	4.5 Servitization	4.5.1 Types of service

Table 3 Examples of Quotations From the Respondents

Respondent	Case Company	Quotation	Code	Sub-theme	Theme
R&D manager	G	"We implement quality by design to reduce the production process and make a consistent quality. Making changes and correct errors is easy when we produce within the designed space. We follow the quality by design with the quality risk assessment to assess the possible quality risk"	Quality by design	QM perception	Internal quality integration
Supply chain manager	A	"When we produce for Europe the materials' specifications and the products' quality differ than if we produce for Jordan"	Different quality in different market		
Quality manager	B	"We are implanting the quality through following GMP and SOPs"	Quality based on the industry's standards		
Technical advisor	E	"Almost 40% of our products are knowledge acquired from external sources such as technical transfer, licenses, and co-development"	Produce new products	Exploitation	Absorptive capacity
Production manager	C	"Our offices are so close we always visit each other and discuss"	Informal assimilation	Assimilation	
Marketing manager	D	"The company is keen to acquire feedback and complaints from the market. While the lecture is a good opportunity for us to listen from the local doctors about their opinions and the latest updates"	Customer feedback	Acquisition	

Continue Table 3

Respondent	Case Company	Quotation	Code	Sub-theme	Theme
Supply chain manager	F	"We work on giving the suppliers feedback to improve their performance. We do not buy in a large quantity that's why they do not care too much about us"	Provide feedback to suppliers	Supplier development	Supplier quality integration
Quality manager	G	"We assess suppliers in every shipment in terms of materials' specifications and delivery time"	Suppliers' evaluation criteria	Supplier evaluation	
Supply chain manager	A	"Usually customers help in developing the product quality using their feedback. Customers have the impact on the external packaging"	Customer feedback	Customer involvement	Customer quality integration
Marketing manager	D	"Last year we did an engagement program with doctors. We did a program to the most 160 influential doctors in Jordan, we gave them continuous medical education program"	Continuous medical education program.	Servitization	
Marketing manager	G	"The agents and wholesalers should respect our quality rules and should be able to maintain it"	Agents' abilities to preserve quality	Customer selection	

Table 4 Cross-case analysis themes

Main sub-themes	Case A	Case B	Case C	Case D	Case E	Case F	Case G
Internal quality integration							
Quality as industry's standards & requirements	✓	✓	✓	✓	✓	✓	✓
Quality by design.					✓		✓
Functions integrated in routine work.	✓	✓	✓	✓	✓	✓	✓
Goals shared between functions.	✓				✓		✓
Supplier quality integration							
Form strategic partnership.				✓	✓		✓
Has a strategic system to purchase, select, evaluate and develop suppliers.					✓		✓
Deals with SC as required from the GMP in terms of suppliers selection, purchasing, evaluation.	✓	✓	✓	✓	✓	✓	✓
Suppliers' performance developed through complaints and feedback only.	✓	✓	✓	✓		✓	✓
Develops suppliers' performance through co-projects.	✓	✓			✓		✓
Customer quality integration							
Proactively deals with customer complaints.					✓		
Reactively deals with customer complaints.	✓	✓	✓	✓		✓	✓
Improves customers' performance by providing services.					✓		
Provides services to customers to increase sales only.	✓	✓	✓	✓		✓	✓
Selects customers to maintain the products' quality.					✓		✓
Customers' selection based on their reputation and financial position only.	✓	✓	✓	✓		✓	
Absorptive capacity							
Acquires strategic knowledge from SC.					✓		✓
Acquires the operational knowledge only from SC.	✓	✓	✓	✓		✓	
Informal way is the most used technique to assimilate SC knowledge.	✓	✓	✓		✓	✓	✓
Creates a special cross sectional project to assimilate the important knowledge.					✓		
Documents mainly used to transform the knowledge and create the work routine	✓	✓	✓	✓	✓	✓	✓
Utilises the external knowledge related to enhance existing products and processes.	✓	✓		✓	✓		✓
Utilises the external knowledge related to producing new products and developing processes.					✓		✓